AGRICULTURAL SYSTEMS

Panel Manager - Dr. Richard S. Gates, University of Kentucky
Program Directors - Dr. Mark Bailey, Dr. Carl Profater

Although agricultural research has most often focused on individual system elements, the Agricultural Systems program provides opportunities for integration of these elements through a systems research program. The objective is to obtain knowledge that is essential to sustain the viability of agriculture. Such research is needed to address directly interactions among the elements that comprise agricultural systems.

This program supports systems research that has the potential to aid in the development and/or evaluation of national, regional, community, and/or farm level practices and policies that will sustain: a safe and adequate supply of agricultural products and services; environmental quality and the natural resource base; human health; and the economic viability and quality of life of rural communities; and address linkages between urban and rural areas.

9703786 Design of an Agroforestry System with Structured Tree Clusters
Zeide, B.; Francis, P.; Kluender, R. **Grant 97-35108-5126**

University of Arkansas **Strengthening Award**
School of Forestry **$97,663**
Monticello, AR 71656-3468 **2 Years**

One tenth of the trees that a forester plants provides at the end of rotation about three quarters of all discounted returns. It is proposed to plant these crop trees (loblolly pine, *Pinus taeda* L., 50 per acre) surrounded by nurse trees (shortleaf pine, *Pinus echinata L.*). The area between rows of tree clusters is utilized for forage and beef production. The coexistence of trees, forage, and livestock is natural and can be mutually beneficial for several biological and managerial reasons. The objectives of this project are to determine tree spacing and schedules for tending trees (pruning and thinning), forage, and animals that will optimize economic, social, and ecological benefits. We will test three types of structured rows, four within-row distances, three thinning intensities, and three levels of pruning for two agroforestry systems (improved agro-silvicultural system and an agro-silvo-pastoral system) in three replications on a 30-acre field in southwestern Arkansas.

9703788 Farmer Goals and Management Strategies: Implication for Adoption of Sustainable Practices
Klonsky, K.; Auburn, J. **Grant 97-35502-5141**

University of California, Davis
Department of Agricultural and Resource Economics **$185,911**
Davis, CA 95616 - 8512 **3 Years**

The overall goal of this three-year project is to identify the barriers and opportunities for the adoption of sustainable farming techniques using farmer goals, management styles and information inputs as the primary determinants. First, farmer goals and management styles will be identified using Q methodology. Management goals and styles will be related to the different production decisions that impact the sustainability of perennial crop production. Second, field and farm level economic and crop performance data will be compared using a variety of sources. Finally, the project will identify the information needs of conventional and biological farmers with respect to goals and management styles, and assess how well existing information delivery and education programs meet those needs. In total, this project will provide a better understanding of the management and information requirements of farmers, explain decision-making processes, compare performance across systems and aid in meeting growers' long-term information needs.

9703960 Agro-Ecosystems Indicators of Sustainability as Affected by Cattle Density in Ranch Management Systems
Campbell, K.L.; Capece, J.C.; Mullahey, J.J.; Fanning, M.D.; Graetz, D.A.; Holt, J.; McSorley, R.; Muchovej, R.M.; Portier, K.M.; Roka, F.M.; Steinman, A.D.;
Tanner, G.W. **Grant 97-35108-5125**

University of Florida, Gainesville
Department of Agricultural and Biological Engineering **$249,476**
Gainesville, FL 32611-0570 **3 Years**

In an effort to restore the sensitive ecosystems of south Florida, large reductions in phosphorus discharges are required from major land uses in the region. Beef cattle pastures cover large land areas resulting in large collective contributions of phosphorus. An interdisciplinary team has launched a project to develop sustainable environmentally-sensitive cattle ranch management practices for the region. The project is using a 16-plot, 1040-acre pasture array system to evaluate the effects of cattle stocking rate on: (1) runoff water quality, (2) biological agro-ecosystem indicators including animal performance, vegetation/forage quality, soil nutrient dynamics, nematode biodiversity, and avian utilization, and (3) ranch sustainability as predicted by economic models that integrate cow-calf performance and other financial considerations. The goal of this project is to provide information regarding the interrelationships and interactions of the overall agro-ecosystem and its sustainability, including tools to evaluate the performance of the overall system.

To test the effects of grazing intensity on water quality and nutrient assimilation, this study will impose four cattle stocking rates on both an improved pasture site and a native range site. Data collected will be analyzed using standard statistical tools to test the hypothesis that stocking rate has no effect on runoff water quality, nutrient assimilation, or biological agro-ecosystem indicators. These studies complement the water quality assessment, hydrologic modeling, and decision support system projects already underway. Together, all of these complementary studies constitute a holistic analysis of ranch agro-ecosystems as affected by cattle stocking density.

9703966 Integrated Assessment of Environmental and Economic Implications of Precision Farming on Crop Production
Tim, U.S.; Batchelor, W.; Kanwar, R.; Mallarino, A.; Babcock, B. **Grant 97-35108-5128**

Iowa State University
Department of Agricultural and Biosystems Engineering **$211,098**
Ames, IA 50011-3080 **3 Years**

Economic pressure and global competition has caused farmers to integrate new technologies into current crop production practices to enhance and profitability and to protect the environment and natural resources. A farming system that is gradually gaining widespread acceptance and adoption within the agribusiness community is precision farming or precision agriculture. Assisted by the rapid advancements in modern information technologies, precision farming permits farmers to obtain detailed and spatially explicit information on field/soil characteristics at much smaller units. By allowing optimal use of farm inputs on a site-specific basis, precision agriculture has been shown to be economically consistent with and in many cases superior to conventional farming practices. However, few studies have examined the environmental benefits of site-specific crop production and the complex interactions among the many factors that influence crop growth, water quality and farm management decisions. This multidisciplinary research project utilizes a systems approach to rigorously evaluate the agronomic, environmental and economic implications of precision farming. Specific objectives are to: collect valuable multi-resource data for evaluating the effects of site-specific chemical application on runoff and leaching losses, develop methods to quantify the spatial variability of crop yields and chemical losses, and measure the potential economic benefits of precision agriculture so that farmers can make informed crop production decisions. The widespread adoption of precision agriculture will require new approaches to research that are designed not only to explain complex interactions between multiple factors influencing crop production, but also to improve our understanding of the agronomic, economic, and water quality impacts.

9703946 An Agricultural Systems Approach to Estimating Land Use Transitions
Plantinga, A.J. **Grant 97-35314-5121**

University of Maine **Strengthening Award**
Department of Resource Economics and Policy **$122, 900**
Orono, ME 04469-5782 **2 Years**

Land use change can have substantial impacts on environmental quality and hence the long-term viability of U.S. agriculture. Policies to limit socially undesirable land use change must recognize linkages between land use and other components of the agricultural system. In the research, we study the relationships between production and land use decisions of producers, markets for agricultural products and inputs, and soil resources. In addition, we consider how land use policies can change the economic incentives faced by producers and thereby result in land use allocations that minimize environmental impacts.

The central objective of this project is to develop a framework that allows us to simulate the effects of land use policies on land use shifts and environmental quality. Commonly-available data on land use can be used to determine net changes in land use; however, in many instances, environmental policy-makers require knowledge of the acreages of land shifting between uses. Information on land use shifts is essential since the environmental impacts of land use change typically do not "net out." We develop a methodology for estimating the complete set of land use transitions using widely-available data from federal sources.

The methodological framework is used to study land use change in Maine and Iowa. The results are then applied to three policy problems: the design of land use regulations to limit urban sprawl (Maine), the use of zoning and other land use policies to encourage sustainable agricultural practices and minimize negative environmental impacts (Iowa), and the management of land-based carbon (Maine and Iowa). This project provides essential information to county-level zoning and agricultural program administrators and state and national policy analysts. To facilitate the transfer of information, this project is a collaborative effort between university researchers and state and federal planners and analysts. Additional beneficiaries will be targeted in efforts to disseminate the results.

9703697 Designing Regeneration Systems for Sustainable Management of Lake States Forested Wetlands
Mroz, G.D.; Reed, D.D.; Chen, J.; Gale, M.; Jurgensen, M.F.;
Liechty, H.O. **Grant 97-35314-5122**

Michigan Technological University
School of Forestry and Wood Products **$181,358**
Houghton, MI 49931-1295 **3 Years**

Forested wetlands comprise about 33% of wetlands in the northern conterminous United States. Timber harvesting is permitted on many of these wetlands but regeneration of desired species following harvests is often a problem because the water table frequently rises to levels near the soil surface, limiting the recovery of natural wetland vegetation as well as artificial tree regeneration. However, studies indicate that both natural and planted regeneration can be encouraged if the proper soil conditions are present. The number size and arrangement of raised microsites, which increase soil aeration, temperature, nutrient

availability, and organic matter decomposition are particularly important to wetland processes that govern regeneration and plant diversity. Our preliminary studies indicate that the basic relationships between microtopography and wetland processes must be understood before harvesting and site preparation techniques can be devised which mimic natural forested wetland disturbance. In this project, we will use bucket mounding to control the volume and arrangement of the aerated areas, and determine what effects microtopographic differences have on wetland processes, the diversity of the natural wetland plant community, and the growth of important forest crop species. Such information is needed to develop environmentally sound harvesting systems for northern forested wetlands.

9703772 High Yield Sustainable Aquaculture
Brune, D.E.; Eversole, A.G.; Hammig, M.D.; Schwedler, T.E.; Collier, I.A. **Grant 97-35209-5127**

Clemson University **Strengthening Award**
Department of Agricultural and Biological Engineering **$115,000**
Clemson, SC 29634-0357 **2 Years**

Aquaculture is increasing at an annual rate of 20% and has become a one billion dollar industry in the U.S. providing nearly 15% of our seafood. Due to limited water supplies, future aquaculture development will likely require captive water systems, where the culture water is treated and reused. Researchers at Clemson University have demonstrated that current industry pond fish production of 5,000 lb/acre can be increased to 12,000 lb/acre through the use of an innovative new technique, The Partitioned Aquaculture System (PAS). This system couples high density raceway culture of fish with paddle wheel-driven high rate algal growth basins for treatment of wastes allowing 100% reuse of culture water in 2-4 acre self-contained culture units. This high productivity from small modular units is ideally suited for small or medium sized farmers. Research to date, suggests that an additional doubling of production to over 20,000 lb/acre may be possible by coupling the fish/algal system to co-culture of filter-feeding, organisms such as tilapia (*Oreochromus niloticus*) and freshwater bivalves (e.g.*Elliptio sp.*). This technique would provide a method to quadruple current pond aquaculture production while recovering wasted nitrogen and phosphorus discharges, which currently pose a eutrophication or pollutant threat to surface and groundwater supplies. This 2-year study seeks to prove this concept of controlled catfish/algal/herbivore co-culture, resulting in a system with 100% captive water, while recovering 50-75% of input nutrients. The overall goal of this research will be to evaluate the PAS concept as a high yield sustainable aquaculture practice that may have widespread application in the U. S.

9703769 Farm and Landscape Water Allocation and Conservation at the Rural:Urban Interface
Kjelgren, R.; Neale, C.; Endter-Wada, J.; Bishop, B. **Grant 97-35108-5123**

Utah State University **Strengthening Award**
Department of Plants, Soils, and Biometeorology **$246,357**
Logan, UT 84322-4820 **2 Years**

This project will investigate conservation strategies to reduce water transfer from agricultural to municipal and industrial uses in rural-urban interface areas. The water conservation potential both agricultural and urban amenity landscapes will be quantified and water conservation strategies will be designed based upon research of consumer, farmer, and water purveyor behaviors. Project personnel will work with local water management institutions and stakeholder groups to increase successful implementation of research findings.

Specific objectives are: predict total agricultural and irrigated landscaped area, using airbone multipsectroal videography; quantify woody plant water use coefficients as a function of reference evapotranspiration; estimate excess agricultural and urban landscape irrigation water applications for different canal command areas in the rural-urban interface; conduct social science research and involve relevant stakeholders to understand existing patterns of behaviors related to water use and to identify landscape and agricultural water conservation strategies that can be implemented.

9703773 Geographic Information Systems and Site-Specific Management for Integrated Crop Production and Nonpoint Source Pollution Protection
Lowery, B.; Hart, G.L.; McSweeney, K.; Norman, J.M.; Harris, R. **Grant 97-35108-5153**

University of Wisconsin, Madison
Department of Soil Science **$273, 452**
Madison, WI 53706-1299 **3 Years**

Agricultural ecosystems are extensively managed landscapes that contribute to a stable social and economic infrastructure in the United States. However, under certain conditions, management of these ecosystems results in environmental degradation. The source of this degradation in some landscapes may come from only a small part of the land area call “critical sites”. These areas include, but are not limited to, depressional areas (mini-basins) and steep-slopes. Depressional areas could contribute to groundwater contamination from agrochemical leaching and on steep slopes to surface water contamination by runoff. We

propose to investigate site-specific agricultural management practices linked to geographic information systems (GIS) to address precision farming for integrated crop production and nonpoint source pollution protection. We will combine GIS with computer simulation models for runoff and leaching to identify critical sites. Model results will be tested to determine if precision agriculture can be used to reduce environmental risk associated with farming landscapes with critical sites. The GIS database will be supplemented with additional soil quality, landscape, climate, and crop yield characteristics. Physical delivery mechanisms and partitioning of nonpoint source pollution between overland flow, leaching, and retention in the crop or soil profiles will be assessed and modeled. Local growers will partner with us in developing profitable, site-specific management practices that integrate crop production with environmental protection.

9703968 A System Approach to Improving Phosphorus Management on Dairy Farms
Powell, J.M.; Satter, L.D.; Converse, J.C.; Bundy, L.G. **Grant 97-35108-5124**

University of Wisconsin, Madison and
USDA-ARS Dairy Forage Research Center **$200,000**
Madison, WI 53706-1108 **3 Years**

The dairy industry is undergoing great change to remain economically viable. Many farmers are expanding their herd size and increasing the purchase of feed. The use of feed and fertilizer onto farms often exceeds livestock and crop nutrient requirements. This can lead to soil nutrient buildup, losses and environmental pollution. The primary concern with phosphorus (P) mismanagement is its runoff into lakes and streams which increases aquatic growth. This project seeks to reduce P accumulation and loss from dairy farms through integrated feed, manure and soil management. The project seeks solutions to a variety of factors that contribute to the "manure problem", such as excessive feeding of nutrients; poor manure handling, storage, and land-spreading techniques; inadequate land for spreading manure and in some cases inappropriate cropping systems to properly recycle manure nutrients; farmers' unwillingness and/or inability to adopt improved practices; etc. The project integrates expertise in ecology, animal nutrition, engineering, soil science, sociology and involves the participation of producers and agribusiness. Surveys, feeding trials and agronomic trials are being conducted to address the key factors affecting P flow on dairy farms. The project anticipates a series of flexible recommendations that could lead to a 50 to 60% reduction in P runoff from dairy farms. Practices should be suitable for reducing environmental impacts under conditions where feeds are imported onto the farm, dairy are fed primarily in the barn, and farms rely on their land base for recycling manure nutrients.